Nevada Department of Transportation

Research Problem Statement

I. Problem Title

Development of Dual-Purpose Desert Tortoise Crossing Culverts

II. Problem Description

While roadways have many effects on ecological resources, two primary concerns are fragmentation of suitable habitat for plants and wildlife (Richard, 1998) and road-related mortality of wildlife species, specifically those whose populations are listed as threatened or endangered under the Endangered Species Act (ESA), such as the Mojave desert tortoise (Boarman, 1997). The Nevada Department of Transportation (NDOT) maintains many hundreds of miles of highway in Mojave desert tortoise habitat, 400 miles of which are protected by tortoise exclusionary fencing. While the exclusionary fencing protects desert tortoises from highway mortality, it does not address the issue of habitat fragmentation, and in fact may add to the problem. Since exclusionary fencing restricts desert tortoise movement even further than the highway itself, it can inhibit or prevent access to seasonal resources, alter tortoise behavior, and can be detrimental to the larger population through reduced gene flow (Peaden, 2017; Boarman, 1997).

The desert tortoise has exhibited a strong preference for movements along desert dry washes (Peaden, 2017). In an attempt to reduce habitat fragmentation in some areas, tortoise exclusionary fencing is connected to drainage features (culverts) that pass under roadways. The intent is that desert tortoises moving along dry washes or the fence line will utilize the culverts to cross under the highway. However, the design requirements of these drainage features commonly conflict with the movement abilities of the desert tortoise. Many of these culverts have large rocks (rip-rap) placed at the openings to minimize the potential for erosion, but the large voids within the rip-rap are an entrapment hazard for desert tortoises and have been known to cause mortality. Backfilling the rip-rap with native soil may have limited utility, as it does well on flat terrain but may be carried away in steeper areas by the voluminous water flows commonly observed in desert flood events. The native soil may have to be replaced often, which is a concern for NDOT maintenance. The idea of a single-purpose desert tortoise crossing structure under the highway that is not designed for hydraulic use has its limitations as well. Due to topographical restraints and variation in flow patterns throughout southern Nevada, there are limited sites where such tortoise crossings may be installed without becoming, by default, a drainage structure during flood events. Without erosion control measures (such as rip-rap) in place, the single-purpose tortoise crossings may succumb to erosion very quickly in some areas. Therefore, there is a need to design and monitor dual-purpose structures for their ability to withstand large hydraulic events while also being easily navigated by desert tortoises.

Although funding is available through the Bureau of Land Management (BLM) to install dual-purpose structures and/or retrofit existing drainage culverts for use as tortoise underpasses, NDOT and other entities continue to struggle to find solutions that can withstand multiple hydraulic events without requiring extensive maintenance, while also providing effective crossing opportunities for desert tortoises. The multiple divisions of

NDOT are interested in finding a solution that works for all. While dual-purpose structures have proven successful in some areas, other areas struggle to find a balance between hydraulic function, maintenance requirements, and tortoise accessibility. Having design plans to retrofit additional drainage culverts, backed by research, will allow NDOT and BLM to move forward with plans to increase desert tortoise connectivity. These new designs may reduce construction and maintenance costs, reduce habitat fragmentation, and increase population viability for the desert tortoise.

III. Objectives

1. Conduct a literature review. Describe the current practices for the development of hydraulic culverts, single-purpose animal underpass crossings, and the conflicts between the two. Describe the characteristics that predict culvert use for animals crossing under roadways, if any. Determine what characteristics are necessary, under a variety of conditions, for structures to function as hydraulic culverts, and which characteristics make or would potentially make an underpass available and attractive to animals, specifically desert tortoises. Compile these findings into a report.
2. Review the regular reports from BLM on the data obtained from cameras placed at the previously modified NDOT tortoise crossings on US 95 (10 crossings between MP CL 121.6 to MP NY 5.1) and US 93 (10 crossings between MP CL 57.9 to MP CL 75.2). Monitor these crossings at regular intervals for hydraulic function, flow levels, maintenance requirements, and tortoise accessibility for 2 years. Create a report summarizing this data and the data from BLM, and analyze the tortoise crossings for their overall effectiveness as dual-purpose structures.
3. Determine the minimum hydraulic needs of various types of culverts under specific topographic conditions, as well as associated erosion control measures, how high of a flow, and what volume the structure can withstand, following the NDOT Hydraulics Drainage Manual, and meeting the state hydraulic requirements. Summarize these requirements.
4. Create a report from the documents created in Objectives 1, 2, and 3. Summarize the current statistics of wildlife culvert use in the desert southwest, focusing on desert tortoises and southern Nevada. Identify and prioritize the characteristics necessary for a structure to function as a dual-purpose culvert. Identify and prioritize the characteristics necessary to retrofit an existing drainage culvert to be accessible to the desert tortoise. Establish criteria for types, sizes, features, and design flow rates of culverts that are good candidates for retrofitting as a desert tortoise crossing while maintaining full hydraulic function.
5. Using the Nussear model and reports from US Fish and Wildlife Service (USFWS) road observation survey data, determine the highest priority areas for establishing desert tortoise connectivity.
6. Select four drainage culverts with the features identified in Objective 4 that are within high priority areas, identified in Objective 5, in desert tortoise critical habitat in southern Nevada and are currently inaccessible or dangerous to desert tortoises. Develop a plan, with engineered drawings, to retrofit these culverts to be dual-purpose structures that are accessible to tortoises maintaining full hydraulic function and withstanding carried sediment and abrasion.

IV. Current Practice and Related Research

The current practice has involved connecting tortoise exclusionary fencing to the entrances of some drainage features that pass under NDOT roadways to create a desert tortoise underpass crossing. While this method has worked in some locations, other areas present a challenge for successfully facilitating tortoise movement under the roadways, as many drainage culvert features are unattractive to tortoises, difficult for the animals to navigate, or dangerous. Some attempts have been made to make the drainage structures more attractive and useful for tortoises, but these may have reduced the hydraulic effectiveness of the culvert or may result in increased maintenance requirements. NDOT does not currently have a standard design for either a dual purpose structure or a crossing structure designed specifically for desert tortoises. More research is needed to find mutually beneficial and cost-effective solutions that increase the movement potential of the desert tortoise as well as addressing hydraulic concerns.

V. Research Methodology

It is anticipated that information to create final designs and recommendations will be collected from interviews with wildlife professionals and hydraulic engineers, expert solicitation, publication reviews, field evaluations, and examination of unpublished data that is available from NDOT, USFWS, BLM, United States Geological Survey (USGS), and Nevada Department of Wildlife (NDOW). Study findings and dual-purpose structure designs will be reviewed by wildlife professionals, agency biologists, hydrologists, and other scientists.

VI. Implementation Potential

This project will be incredibly valuable to various NDOT Divisions such as Environmental, Construction, and Maintenance, as well as other entities including USFWS, NDOW, BLM, and other state Departments of Transportation. The products of this research should provide innovative approaches that can enable engineers and environmental scientists to implement more effective solutions, encourage teamwork, and maximize the taxpayer's dollar.

VII. Urgency and Payoff Potential

It is extremely important to determine how we can facilitate safe crossings for the desert tortoise in order to minimize the potential for inbreeding depression caused by habitat fragmentation. Without designs that can serve as both a tortoise crossing and a drainage structure, NDOT will continue to face challenges associated with project needs as well as commitments made through the Endangered Species Act consultations. Having a BMP manual for dual-purpose structures and retrofitting existing structures will enable NDOT to add efficient and effective mitigation elements to projects to further the conservation of the desert tortoise. The results of this study and the BMP manual may also inform efforts to resolve culvert design issues for numerous species of turtles and tortoises in other ecosystems.

VIII. Estimated Budget

Unknown

IX. Date and Submitted By

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X. NDOT Champion, Coordination, and Involvement

The primary user will be NDOT Environmental Services, but it will be extremely important to actively involve NDOT Hydraulics, NDOT Constructability, NDOT Maintenance, and other NDOT divisions as required. Other divisions and agencies that will benefit from this design include NDOT Construction, Planning, Design, Stormwater, as well as USFWS, BLM, NDOW, USGS, Federal Highway Administration (FHWA), Utah Department of Transportation (UDOT), Arizona Department of Transportation (ADOT), CalTrans, National Park Service (NPS), Nevada State Parks, California State Parks, Utah State Parks, Arizona State Parks, California Department of Fish and Wildlife (CDFW), Utah Division of Wildlife Resources (UDNR), and Arizona Game and Fish Department (AGFD).

References

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